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Musculoskeletal symptoms and ergonomic risk assessment among production operators at manufacturing industries: A review

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Abstract. Musculoskeletal symptoms are prevalent and represent the most common health problem among manufacturing operators in industrial-developing countries, with considerable costs and impact on quality of life. Because of incorrect workstations and lack of employee education in basic biomechanical principles, many of the workers are still in high risk injury. The aim of this study is to understand the impact of ergonomics implementation among production operators as the risk factors of musculoskeletal symptoms. Operators are normally exposed to a variety of risk factors such as awkward and static postures, repeat movement, and powerful effort. Manufacturing operators are thus considered at risk from developing musculoskeletal symptoms (MSSs). This review evaluates selected papers in manufacturing industries that have studied risk factors of musculoskeletal symptoms among manufacturing operators. Furthermore, other related industry studies have been reviewed as applicable. To understand the risk factors of musculoskeletal symptoms among manufacturing operators, it is recommended that future studies be required to assess these risk factors among manufacturing operators.

1. Introduction

In a working population, musculoskeletal symptoms (MSSs) are the most common and leading cause of occupational injury and disability in developed and industrial developing countries [1][2]. Musculoskeletal symptoms (MSSs) in a working population are the most common and leading cause of occupational injury and disability in developed and industrial developing countries [1][2]. Production operators are potentially exposed to ergonomic hazards or risk in the manufacturing process. Age, gender, height, weight, smoking status and physical activity may influence the occurrence of MSSs [4].

Lower back pain (LBP) and shoulder pain were regularly described as a high risk to manufacturing operators in most manufacturing industries where there was exposure to different musculoskeletal symptoms and mostly uncomfortable postures and repetitive movement.[5] [6] [7]. Studies claimed this disorder was caused by continuous standing, reaching, bending, pushing, pulling, and twisting among manufacturing operators. In addition, the worker's body's shoulder pain is usually exposed to physical load in different tasks with the risk of developing MSSs [8].

2. Risk Factors among Production Operators in Manufacturing Industries

In almost every year, musculoskeletal symptoms among manufacturing operators are increasing. In the absence of an efficient work injury prevention program and the execution of incorrect methods, "poor technique" is widely reported as causing injury among manufacturing operators [9]. According to Social Security Organization, SOCSO (2016), it was reported that many workers from all around industries are experiencing many types of musculoskeletal symptoms (MSSs) and the cases are still increasing [10]. In recent years, the study of risk factors affecting workplace musculoskeletal health issues has been an important area of research focus. These risk factors were commonly grouped as individual, physical, and psychosocial or organizational factors in the work environment [11]. Further research findings can



be found in Table 1 from several reviews of risk factors of musculoskeletal symptoms among manufacturing operators.

Table 1. Further research findings

AUTHOR	TITLE	FINDINGS
Aghilinejad et al., (2012)	Work-related musculoskeletal complaints among workers of Iranian aluminum industries.	The most frequent musculoskeletal complaints in the neck, shoulder, and lumbar. Study also showed that job duration and age were significantly associated with musculoskeletal symptoms in the different body regions.
Dianat et al., (2015)	Association of individual and work-related risk factors with musculoskeletal symptoms among Iranian sewing machine operators.	Work organization factors including long duration of sitting work without a break and prolonged working hours per shift, as well as other work-related variables such as the number of years worked as an operator and feeling pressure due to work were also found to be associated with the occurrence of musculoskeletal symptoms in different body regions.
Foong MC et al., (2014)	Prevalence of Musculoskeletal Symptoms Among Production Line Workers in a Printing.	The prevalence of musculoskeletal symptoms was 79.6%. The most common musculoskeletal symptoms were from the lower back (48.0%).
Sealetsa, O. J., & Thatcher, A. (2011)	Ergonomics issues among sewing machine operators in the textile manufacturing industry in Botswana	Back, neck and shoulder discomfort are highly prevalent among these sewing machine operators. Prevalence rates of 70% for the upper back, 63% for the lower back, and 61% for the shoulders and mid-back region.
Merisalu et al., (2016)	Predictors and prevalence of musculoskeletal disorders among sewing machine operators	The respondents assessed pain in the neck, lower back, and both on the right and left side of shoulders, elbows, wrists/hands and knees. The questions about individual, physiological and psychological risk factors and health behavior were included.

2.1 Awkward Postures

Posture refers to the position of your body's various parts. Muscles, tendons and ligaments have to work harder and can be stressed in an awkward position [12]. In a case study that conducted manufacturing process automation in Korea. It has been stated that the number of cases of MSSs is increasing frequently in each year. One of the factor related of MSs was awkward postures by workers/operators especially in assembly part section [13]. Operators who work in uncomfortable positions can increase the risk of low back pain [14]. O'Sullivan (2012) also mentioned that Prolonged sitting periods, for example periods exceeding 30 min, are a common aggravating factor for many subjects with low back pain.

2.2 Force of Exertion

Force is the amount of effort our bodies have to make in lifting objects, using tools, or moving. Since, as a rule, there is not enough time for recovery in repetitive work, the more powerful movements develop tiredness much faster. [12]. According to Department of Environmental Health and Safety of IOWA State University (2013), forceful movements refers to the amount of effort needed to perform a task or motion. Younger people have been reported to have a higher predisposition to develop low back MSSs, as it is more common for younger people to carry out activities that require strong movements and postures, making them more susceptible to low back MSSs [15]. In contrast, older individuals may perform activities that do not require as much physical effort; they are more likely to perform activities

that demand more precise upper limb tasks instead, such as computer-related activities and line assembly tasks [15].

2.3 Repetition Motion

Repetition rate is defined as the average number of movements or exertions performed within a unit of time by a joint or body link or performing similar movements with the same part of the body with little rest or recovery [12]. Repetition puts workers at an increased risk of injury when other risk factors, such as an awkward posture or heavy force, are also present. [16] [17]. According to findings, due to standardized workstations, high incidence of musculoskeletal symptoms and related physical problems in the manufacture of textiles and clothing was highly repetitive. [3]. In some of the earliest studies reported in the ergonomics literature on sewing machine operators, operators reported pain in the past 12 months in at least one region of the body and most often in the lower back, neck and wrist / hand [18] and neck, shoulders and lower limbs. [19].

2.4 Vibration

Vibration results in effects such as damage to body organs caused by high levels of vibration at relatively low frequencies and breakdown of body tissue due to either continuous resonance or high energy vibration absorption. [12]. Exposure to WBV occurs when vibrations are usually transmitted through the feet when standing or when sitting on the legs and hips. WBV, including internal organs, can affect the whole body. The whole body's exposure to vibration (usually through the feet / buttocks while riding in a vehicle) has some support as a risk of injury. [16] [12]. Van et al. (2016) noted that workplace vibration exposure and work stress were a significant risk factor for neck, shoulder, lower back and upper back discomfort or pain. [20]. Other than that, in a study among operators of construction equipment that carried out by Kittusamy & Buchholz (2004), analyzed that whole body vibration (WBV) and the postural requirements of work (both static and awkward postures) are important risk factors that contribute to the development of musculoskeletal disorders among Operating Engineers (OEs) [21].

3. Musculoskeletal Symptoms (MSSs) among Production Operators at Manufacturing Industries

According to Saraj Zadeh Fard (2016) studies, the highest prevalence rates of musculoskeletal symptoms were observed in health- care providing industry followed by manufacturing industries [22]. As shown in figure 1, the occupational diseases & poisoning by sector in Malaysia.

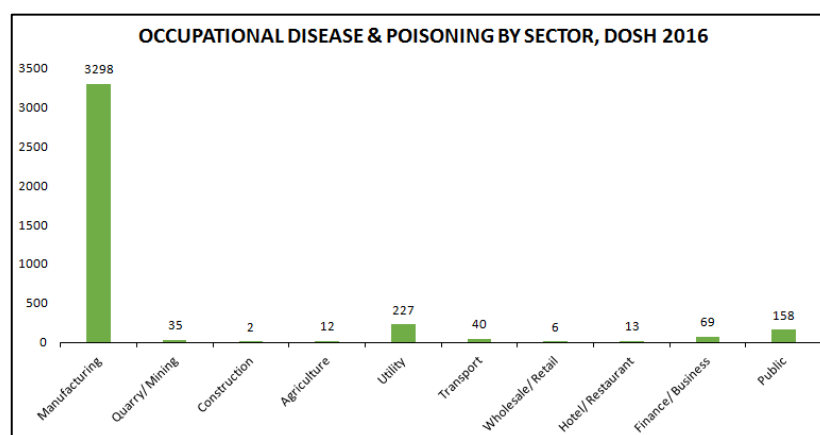


Figure 1. Occupational Disease & Poisoning by Sector (DOSH 2016)

During that time, most manufacturing operators faced inappropriate working conditions and this made it easy for operators to engage in panic-induced injuries or accidents, hot, stuffy and dusty environments, lack of ventilation and overtime work. [8]. Work-related MSD involves inflammatory and degenerative processes which can involve muscles, tendons, cartilages and joints, causing pain and

impairment of function. [23]. Musculoskeletal symptoms risk factors are work activities such as awkward and static postures, handling materials manually, repetitive movements as well as individual, psychosocial, and organizational factors which known as important predictive variables at manufacturing industries lead to various types of symptoms [22] [24]. Figure 2 and 3 shows the some examples of the musculoskeletal symptoms among production operators at manufacturing industries.



Figure 2. Lifting in pinch causes hand/wrist pain



Figure 3. Awkward postures that causes low back pain

3.1 Low Back Pain (LBP)

Low back pain (LBP) is one of the most common occupational health problems in modern industrialized societies and accounts for a large number of days of compensation and disability for workers [25][26][27]. The NIOSH report stated that the entire body's awkward working postures, lifting and vibration were risk factors for symptoms of low back [15]. Physical factors, heavy lifting and repetitive hand movement were closely related to low back pain reporting. Working with repetitive hand movements or working with awkward hand postures may involve light material handling that would repetitively load the back and may result in increased risk of back pain. [11]. Studies have shown that workers may feel exhausted for the prolonged standing position, seats have not been provided as the task requires standing and awkward posture most of the time and this could be another possible explanation for the higher rate of musculoskeletal symptoms on back pain [4].

3.2 Hand/Wrist Pain

Computer work, heavy physical work and vibration were stated on the NIOSH report as risk factors for the development of wrist / hand pain. Eatough et al. (2012) stated that operators with higher job control are able to have greater autonomy and therefore take more breaks, help their muscles and reduce the risk of developing musculoskeletal symptoms associated with work [28]. In another case study conducted in the textile manufacturing industries, it was stated that poor posture in the workstation such as incorrect table and chair heights and unadjustable equipment and the highly repetitive nature of the work are likely to contribute primarily to the high incidence of MSSs. [3]. The table height requires the operator to flex and extend the arm repeatedly, and to flex much of the load [3][15] on the wrist bearing. Using a force on an individual or object can overload our muscles and tendons [16]. Kolgiri (2016) also stated that the force may come from gripping, lifting, pushing or pulling and this pinch grip produces 3-5 times more force on the tendons in the wrist than a grip with the whole hand. With excessive force the muscles are contracting much harder than normal, this can lead to stress on the muscles and joints especially in wrist.

3.3. Shoulder Pain

For workers with shorter working hours, the shoulder pain was significantly higher because the workers who had frequent lifting had a high prevalence of pain in the shoulders [29]. Risk factors such as repetition of work, hard work, and awkward position, twisted and bent position, working with arms raised to shoulder level, and handling heavy weights can also lead to disorder of the upper limbs, particularly of the shoulders. Studies have shown that the prevalence of shoulder pain in the general population may be as high as 6%-11% below 50 years of age, increasing to 16%-25% in the elderly [8].

4. Conclusion

To sum up, there was a high prevalence of musculoskeletal symptoms among manufacturing operators with a high proportion of symptoms in the lower back, shoulders, knees, and neck. Furthermore, from the point of view of the type of activity, the prevalence rates of MSs in all body regions were higher among operators with dynamic jobs as compared to those of workers with static jobs. Risk factors such as heavy load lifting, repetitive movements, long-term standing position, and extra force exertion appear to be causes of high prevalence of musculoskeletal symptoms among workers with dynamic jobs. In order for operators in the manufacturing industry to handle their work efficiently, further studies should focus on appropriate working positions.

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